

Appendix 4—Functional Requirements

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1. INTRODUCTION

1.1. Document Overview

This requirements document is divided into five major sections. Section 1 explains the scope of the document as a whole. Section 2 provides an overview of the **System** and the concept of operations. Section 3 describes the System requirements in detail for the **Toll Collection System (TCS)**. Section 4 describes the security requirements for the System. Finally, Section 5 describes the safety requirements related to installation of the System.

1.2. Document Scope

The requirements set forth herein describe the TCS that **WSDOT** desires to procure for the SR 520 Bridge. These functional requirements will be used as a baseline from which the **Vendor** will develop a more detailed System Design Document.

1.3. Abbreviations and Definitions

All capitalized terms and abbreviations used in this Appendix 4, but not expressly defined herein, have the respective meanings set forth in **Appendix 1 -- Definitions**, attached to the RFP.

1.4. Naming Conventions

Functional requirements are individually labeled with an abbreviated general descriptor and a requirement number. For example, the label “SR520-4.1” refers to the first functional requirement for the TCS in Appendix 4.

2. SYSTEM OVERVIEW

The TCS described herein will provide a means for WSDOT to collect tolls in an Open Road Tolling configuration on the SR 520 Bridge via radio frequency identification and Image Capture technologies. The SR 520 facility will have one tolling location with two **Toll Zones**, one in each direction, located near the east end of the SR 520 Bridge. The TCS will service both east and westbound traffic, and it will operate 24 hours per day, 7 days per week. The System will include all Toll Zone **Hardware** and **Software** and the facility administration systems required to support operations, administration, and maintenance. The TCS will not include customer service, customer account maintenance, or similar functionality.

Figure 2-1 illustrates a high-level conceptual view of the System. It depicts the **Facility Management and Administration System** (shown in the cross-hatched box), the Toll Zone Hardware (shown in the dotted box), and the interfaces that will connect to the System.

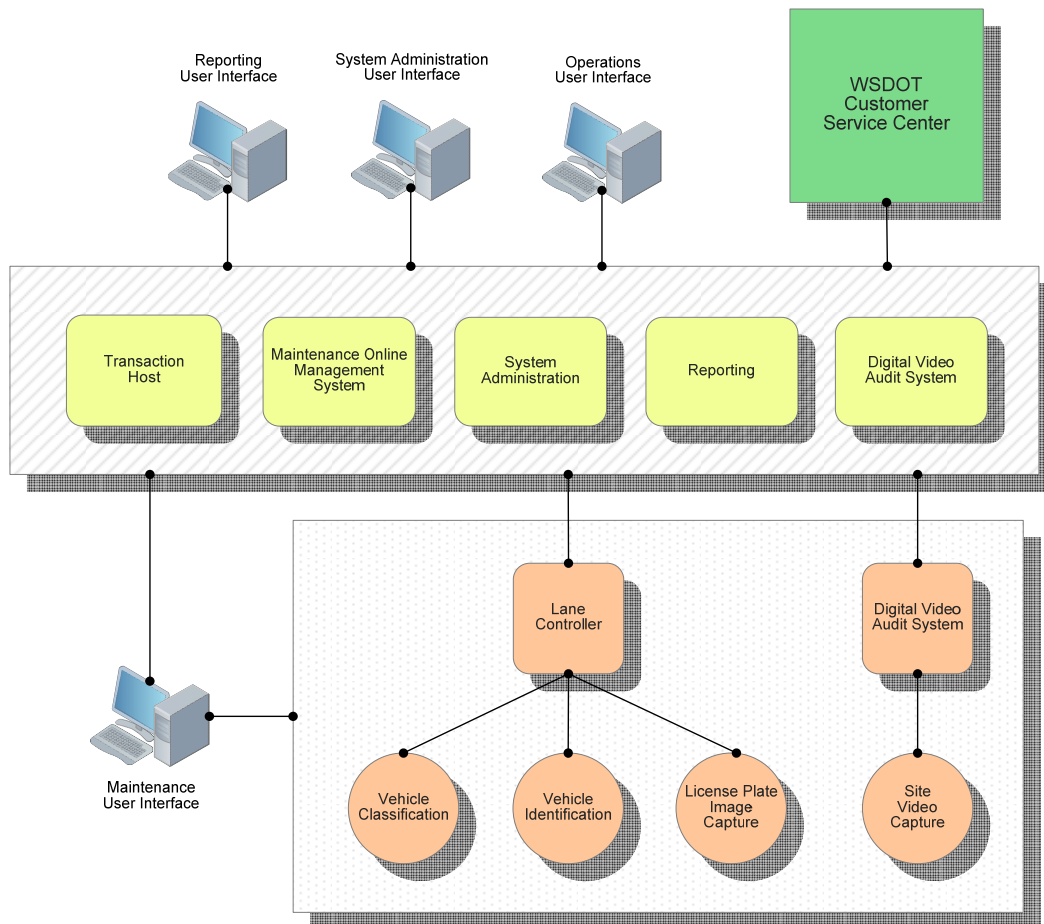


Figure 2-1—Toll Collection System

3. FUNCTIONAL REQUIREMENTS

3.1. General

SR520-4.1 The design of the **Work** shall be completed and documented in English units of measure.

3.1.1. System Architecture

SR520-4.2 The System shall be fully redundant such that no single failure can result in the complete loss of revenue collection.

SR520-4.3 Data exchange between different subsystems shall be carried out via secure protocols safeguarding the integrity of the data.

SR520-4.4 These protocols must meet or exceed the current Washington State **ISB** Security Standards. These can be found at <http://isb.wa.gov/policies.aspx>.

3.2. Roadside System

3.2.1. Description

SR520-4.5 The **Roadside System** shall be modular in design, allowing for expedited removal and replacement during lane closures.

SR520-4.6 The Roadside System shall include **Automatic Vehicle Identification (AVI)**, **Automatic Vehicle Classification (AVC)**, and Image Capture subsystems.

SR520-4.7 The lowest portion of the Roadside System over the roadway shall have a minimum clearance of nineteen (19) feet above the roadway surface, including the shoulder.

SR520-4.8 All components of the Roadside System visible to the public shall be limited to subtle (muted) colors that will not distract or startle or otherwise impair or interfere with motorists driving in either direction of traffic.

SR520-4.9 All components of the Roadside System installed will include bird exclusion devices to discourage nesting, where warranted.

3.2.2. Lane Controller

3.2.2.1. General

SR520-4.10 The **Lane Controller** and its peripheral systems shall be capable of full toll collection operations without connection to the **Host**.

SR520-4.11 The Lane Controller and its peripheral systems shall fully operate in an automated fashion without intervention from operational personnel.

SR520-4.12 The Lane Controller shall transmit all **Transaction** data to the Host when network connections allow.

3.2.2.2. Transaction Creation

SR520-4.13 If a vehicle passes through the Toll Zone with a **Transponder** of “valid” or “low balance” status, the Lane Controller shall create a **Transponder Transaction**.

SR520-4.14 If a vehicle passes through the Toll Zone without a Transponder or with a Transponder of any status other than “valid” or “low balance,” the Lane Controller shall create an image-based Transaction.

SR520-4.15 The Lane Controller shall correctly correlate 99.95% of all Transaction data into a single Transaction for each vehicle that passes through the Toll Zone.

SR520-4.16 The Lane Controller shall be able to process up to five (5) **Transponder Declaration States**.

SR520-4.17 The Lane Controller shall include at least the following information in the Transaction message:

- a. Transaction **ID**
- b. Transaction date and time (local time)
- c. Facility/Roadway
- d. Toll Zone ID
- e. Lane ID
- f. Transponder ID (if applicable)
- g. Transponder Declaration State (if applicable)
- h. Transponder issuing agency (if applicable)
- i. Transponder status (if applicable)
- j. Pointer to associated image (s)
- k. **Optical Character Recognition (OCR)** determined plate characters (if applicable)
- l. OCR determined plate jurisdiction (if applicable)
- m. OCR determined plate type (if applicable)
- n. OCR determined confidence level (if applicable)
- o. AVC determined vehicle classification (if applicable)
- p. CSC provided vehicle classification (if applicable)

- q. Base Toll rate
- r. Discounted Toll rate
- s. Vehicle speed
- t. Any unusual occurrence attributed to the System
- u. Roadside System status

3.2.2.3. Data Storage

- SR520-4.18 The Lane Controller shall record and retain all data transmitted from its peripheral systems, including all Transactions, images, and maintenance data for a period of at least thirty (30) **Calendar Days**.
- SR520-4.19 If communication with the Host is lost, the Lane Controller shall store and queue Transaction and maintenance data.

3.2.2.4. Communications

- SR520-4.20 The Lane Controller shall transmit all Transaction and maintenance data to the Host in the order it was received.

3.2.3. Vehicle Detection

- SR520-4.21 The Automatic Vehicle Classification (AVC) system shall detect 99.9% vehicles passing through the Toll Zone according to the vehicle classification schedule approved by WSDOT.
- SR520-4.22 The AVC system shall measure the speed of all vehicles traveling up to and including 100 **MPH** to within ± 1 mph.

3.2.4. Vehicle Classification

- SR520-4.23 The AVC system shall have the ability to perform shape-based and axle-based classification.
- SR520-4.24 The AVC system shall classify 99.8% of the vehicles at speeds up to and including 100 MPH.
- SR520-4.25 The AVC system shall classify vehicles in all environmental and lighting conditions found at the site.
- SR520-4.26 The AVC system shall correctly distinguish between individual vehicles and vehicles towing one (1) or more trailers.
- SR520-4.27 The System shall accommodate a minimum of ten (10) vehicle classes regardless of Transponder Declaration State.
- SR520-4.28 Transactions shall be immediately flagged for vehicle class mismatch.

3.2.5. Vehicle Identification

- SR520-4.29 The AVI system shall correctly detect, read, and write back to 99.9% of all properly installed Transponders on vehicles driving through the Toll Zone at speeds up to and including 100 MPH.
- SR520-4.30 The AVI system shall support **Super eGo**[®] and **ASTM** v6 Transponder protocols.
- SR520-4.31 The AVI system shall incorporate error-checking protocol to ensure accurate data transmission between the Lane Controller and the AVI reader.
- SR520-4.32 For each Transponder that passes through the Toll Zone, at a minimum the AVI reader shall transmit the Transponder read date and time, unique identification number, state, issuing agency, and status to the Lane Controller.
- SR520-4.33 Following a successful read, the AVI reader shall write the date, time, Toll Zone, Transponder Declaration State, and **Transponder Account** status (e.g., valid, low balance, etc.) data back onto the Transponder.
- SR520-4.34 The AVI system shall prevent an AVI reader in a lane from reading the Transponder of vehicles traveling in the adjacent lanes.
- SR520-4.35 The AVI system shall prevent Transponder reads from being assigned incorrectly to leading or trailing vehicles (tailgating).
- SR520-4.36 The AVI system shall detect, read, and write back to properly installed Transponders on vehicles straddling adjacent lanes.
- SR520-4.37 The Vendor shall design the System to correlate vehicle detection and classification data with AVI detection and Image Capture.

3.2.6. License Plate Image Capture

3.2.6.1. General

- SR520-4.38 The System shall capture at least one (1) front image and one (1) rear image, that is human readable, for at least 99% of the vehicles, including motorcycles, driving through the Toll Zone at speeds from five (5) miles per hour up to and including 100 miles per hour.
- SR520-4.39 The System shall capture images of all vehicles that pass through the Toll Zone, regardless of whether they are in one lane, straddling two lanes, or driving on the shoulder.
- SR520-4.40 The System shall comply with RCW 46.63.160 7(a), which limits photo enforced images to the vehicle and vehicle license plate only.

SR520-4.41 At least one (1) vehicle image shall include a legible license plate, if one exists.

SR520-4.42 The **Image File** naming convention shall be decided during **Interface Control Document** development, however, the filename shall include at least the following information, unless otherwise approved in writing by WSDOT:

- a. Size of image in pixels (resolution)
- b. Cropped (yes or no)
- c. OCR plate number output (if applicable)
- d. OCR plate type output (if applicable)
- e. OCR plate jurisdiction output (if applicable)
- f. OCR confidence level (if applicable)
- g. Region of interest in pixels (top left and bottom right pixel locations)

3.2.6.2. Optical Character Recognition (OCR)

SR520-4.43 The OCR engine shall return a correct result for 90% of the human readable license plate images captured by the System.

SR520-4.44 The System shall process all vehicle images through one (1) or multiple OCR engines.

SR520-4.45 The OCR engine shall produce plate number, plate type, and jurisdiction of issue for the license plate images when an OCR value is returned.

SR520-4.46 When the OCR values for the front and rear plate of a vehicle do not match, the OCR value for the front plate will be appended to the Transaction.

3.2.6.3. Supplemental Lighting

SR520-4.47 The supplemental lighting design shall not blind or otherwise impair the vision of motorists approaching and departing the Toll Zone.

SR520-4.48 The supplemental lighting design shall not blind or otherwise impair the vision of motorists in adjacent lanes and roads or motorists traveling in the opposite direction.

SR520-4.49 Supplemental lighting for vehicle license plate Image Capture shall not distract or startle or otherwise impair or interfere with motorists driving in either direction of traffic.

- SR520-4.50 Supplemental lighting shall either be infrared or be shielded and directed toward the road deck, resulting in minimal additional light reaching the surrounding environment.

3.2.7. Cabinets and Enclosures

- SR520-4.51 The service cabinets shall initially be provided and installed by WSDOT and be Model 334 with front and back access doors; 66”H x 24”W x 30”D dimensions and 0.125 inch aluminum material.
- SR520-4.52 Any replacement service cabinets shall be provided and installed by the TCS Vendor and shall be identical to the model initially provided unless otherwise approved by WSDOT. Vendor shall obtain a Permit from WSDOT prior to any such installation.
- SR520-4.53 Service cabinets shall have a mill finish, the aluminum shall not be anodized, and the exterior shall not be painted.
- SR520-4.54 Service cabinet doors shall be four-hinged with a two-position door stop assembly and a three point latch.
- SR520-4.55 The service cabinet bonding connection shall be a welded plate with stainless steel hardware, Belleville washers, cu/al lug, and antioxidant compound. The bolt shall be torqued to fully compress the Belleville washers.
- SR520-4.56 Steel conduit penetrating the service cabinet shall have a grounding bushing and shall be bonded to the system ground.
- SR520-4.57 All equipment enclosures and housings shall be stainless steel constructed to National Electrical Manufacturers Association (**NEMA**) 4X standards.

3.2.8. Uninterruptible Power Supply

- SR520-4.58 The System and its components shall be properly grounded and shall be protected by an Uninterruptible Power Supply (**UPS**) capable of supplying conditioned electricity, suitable for the operation of the Products it supports, during normal operations.
- SR520-4.59 In the event of a power disruption, the UPS shall provide continuous stable power, suitable for the operation of the Products it supports, for a period no less than two (2) hours.
- SR520-4.60 Each UPS shall filter power to eliminate power spikes and under-voltages and shall report power problems and malfunctions to **Maintenance Online Management System (MOMS)**.

- SR520-4.61 Any power fluctuation that deviates beyond configurable parameters, all on/off state changes, and other power anomalies shall be logged so the data can be reported on.

3.2.9. Emergency Generator

- SR520-4.62 The emergency generator shall initially be provided and installed by WSDOT.
- SR520-4.63 Any replacement generators shall be provided and installed by the TCS Vendor and shall be identical to the model initially provided unless otherwise approved by WSDOT. Vendor shall obtain a Permit from WSDOT prior to any such installation.
- SR520-4.64 The generator shall be powered by diesel fuel and the fuel system shall use preservatives or other methods to keep the fuel usable by the generator for a minimum period of five (5) years.
- SR520-4.65 The generator's fuel tank shall be sized to run under full load for a minimum of seventy-two (72) continuous hours.
- SR520-4.66 The generator shall be self-starting and incorporate automatic switching gears such that upon loss of utility power, the generator begins operation and supplies power for all Products it supports before UPS power ends. Thus, continuous operation of the Toll Zone shall be possible, regardless of power outages in the lane.
- SR520-4.67 The generator's rated output shall meet the required input of the Products it supports even after de-rating for high and low temperatures and elevations which may be present at the installed locations.
- SR520-4.68 The generator shall have adequate capacity, beyond supplying power to the site, to recharge the UPS unit(s).
- SR520-4.69 The generator shall include a 110% spill containment system for all engine and radiator fluids. This shall be detailed in the Spill Prevention Control and Countermeasures Plan developed by the Vendor and approved by WSDOT.
- SR520-4.70 The generator shall operate within the noise requirements outlined in the Medina Municipal Code, Chapter 8.06, during testing operations.

3.3. SR 520 Facility Management and Administration System (FMAS)

3.3.1. General

The **FMAS** is the user-centered data repository that houses the applications that facilitate operations, administration, and maintenance of the System. The FMAS shall provide WSDOT with an accurate and auditable solution that enables efficient daily operations,

delivers timely reports, and supplies useful and reliable maintenance information. **Figure 3-1** is conceptual and displays various System devices that may either be nominal or actual unique servers, devices, or applications within the FMAS. The boxes on the left of the FMAS (as shown below) represent the anticipated data input sources, while the workstations on the right of the FMAS (as shown below) represent the anticipated user interface connections. All of the data from the FMAS will be fed to the WSDOT CSC.

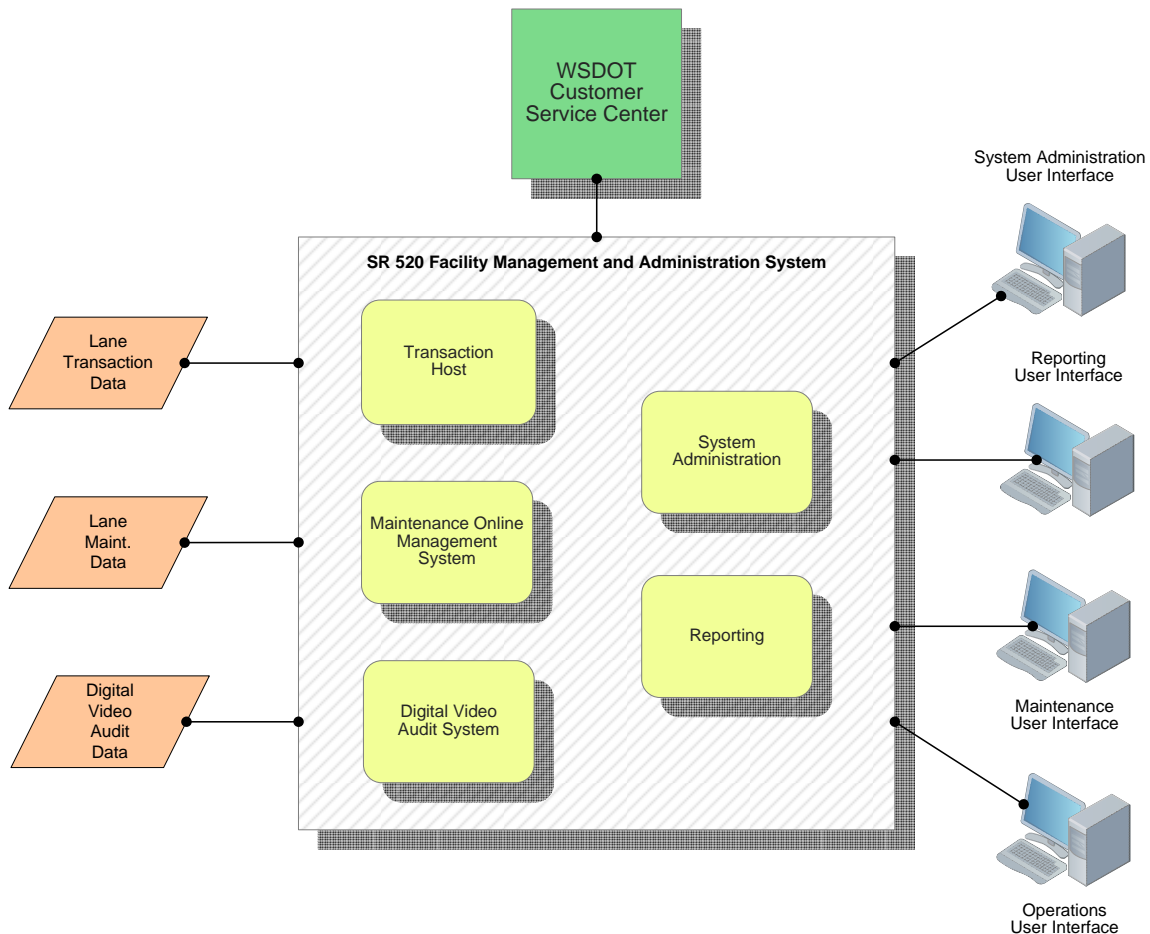


Figure 3-1—FMAS

3.3.2. Time Synchronization

SR520-4.71 The FMAS shall synchronize the date and time by the master clock at <http://tycho.usno.navy.mil/>, or another WSDOT-approved time source at least once every thirty (30) minutes.

SR520-4.72 The FMAS shall automatically adjust the date and time to conform to Daylight Savings Time.

3.3.3. Host

- SR520-4.73 The Host shall receive all Transactions, vehicle images, and other associated data from each Lane Controller.
- SR520-4.74 The Host shall transmit all Transactions, vehicle images (when requested), and other associated data to the WSDOT CSC via the CSC interface, as directed by WSDOT.
- SR520-4.75 The Vendor shall collaborate with WSDOT and the CSC Vendor on the development of an Interface Control Document (**ICD**) for the WSDOT CSC interface.
- SR520-4.76 The Host shall store all Transaction data online for a period of ninety (90) Calendar Days.
- SR520-4.77 Upon receipt of Transponder status data from the WSDOT CSC, the Host shall immediately transmit the data to all Lane Controllers. Where a Lane Controller is offline, the Host shall retry, a user-configurable number of times, to transmit the data to the Lane Controller. The Transponder status data shall be sent from the CSC to the TCS at least every day and updates to the data shall be sent at least every hour.
- SR520-4.78 Upon direction by an **Authorized User**, the Host shall transmit Lane Controller configuration data to the Lane Controller.
- SR520-4.79 At a minimum, the Host shall compile the Transaction detail report, which measure traffic statistics for each Toll Zone, including traffic volumes by vehicle classification, Transaction type (Transponder or image based), average speed, and traffic density over user-configurable intervals. See Section 3.3.6.1, Defined Reports, for more detail.
- SR520-4.80 The Host shall store data to non-volatile memory upon receipt or generation to minimize the loss of data in the event of a power failure or other System failure.
- SR520-4.81 In the event of data loss at the Host due to Product failure, the Host shall have the ability to retrieve the lost data from the Lane Controller for the original date of data generation.
- SR520-4.82 The Host shall include a filter to account for duplicate Transaction data.
- SR520-4.83 The Host shall be monitored by separate Software or Hardware (e.g., a watchdog) that will notify maintenance staff when the Host or supporting services lock up, reboot, fail, or lose network connectivity.
- SR520-4.84 The Host shall prevent unauthorized users from gaining access to the Host.

SR520-4.85 Each user shall be assigned a personal user name and password, in accordance with the ISB security policies and standards available at <http://isb.wa.gov/policies.aspx>, for logging into Host.

3.3.4. Maintenance Online Management System

SR520-4.86 During the Vendor-provided **Warranty and Maintenance Period**, the MOMS shall be the primary application for all System maintenance activities, including preventive maintenance, emergency maintenance, real-time monitoring, repair calls, and report generation.

SR520-4.87 During a **Shared Maintenance** term (if applicable), MOMS shall operate in a supplemental role to **Signal Inventory Maintenance Management System (SIMMS)**; however WSDOT retains the right to utilize MOMS as the primary application for all System maintenance activities.

SR520-4.88 In the event a third party MOMS is provided, reports required to support maintenance reporting shall be consolidated by the Vendor.

SR520-4.89 The MOMS shall utilize a **GUI** that allows Authorized Users to view, update, and query the MOMS database.

SR520-4.90 The MOMS shall allow for near real-time monitoring and control of Product failures within the System.

SR520-4.91 The MOMS shall monitor all components of the System to determine Product status and, in turn, keep record of the status for processing and reporting purposes.

SR520-4.92 The MOMS shall monitor all processes and services required to operate the System.

SR520-4.93 The MOMS shall provide automatic ticket escalation functionality.

SR520-4.94 At a minimum, the MOMS shall be capable of providing the following information to its users:

- a. Current System status (level defined by user)
- b. Toll Zone operation status (system health for each Toll Zone)
- c. Failure and/or malfunction location/time
- d. Failure and/or malfunction description (including both initial **Priority Level** and current Priority Level, if applicable)
- e. Spare parts management
- f. Part/Product description (including part/serial no.), if applicable

- g. Record of last maintenance activity for a Product entered by maintenance staff
- h. Record of last preventive and emergency maintenance activity for a Product as entered by maintenance staff
- i. Historical System information/report generation

SR520-4.95 The MOMS shall be monitored by separate Products (e.g., a watchdog) that will notify maintenance staff when MOMS or supporting services lock up, reboot, fail, or lose network connectivity.

SR520-4.96 The MOMS shall be configurable to meet WSDOT's operations requirements and shall support the Vendor's maintenance requirements specified within the **Contract**.

3.3.4.1. Remote Operations

SR520-4.97 The MOMS shall allow technicians and other users to access the MOMS application over the Internet without impacting the flow of data between the Lane Controller and the Host.

SR520-4.98 The MOMS shall prevent unauthorized users from gaining access to the MOMS.

SR520-4.99 Each user shall be assigned a personal user name and password for logging into MOMS.

3.3.4.2. System Monitoring

SR520-4.100 The Lane Controller shall determine the operational status of each device at a minimum every five (:05) seconds.

SR520-4.101 The Lane Controller shall monitor each device to detect and record that the device has failed, is intermittent, or is degrading in its performance level.

SR520-4.102 The Lane Controller shall flag each Transaction that occurs when the AVI, AVC, Image Capture, and/or **DVAS** subsystems are less than fully functional.

SR520-4.103 The MOMS shall include a filter to account for duplicate MOMS data.

SR520-4.104 The MOMS shall monitor Transaction counts and the performance of the OCR and detect and record significant changes.

SR520-4.105 The MOMS shall have the ability to generate **Work Orders** with no human intervention.

- SR520-4.106 The MOMS shall also have the ability to generate, at a minimum, three (3) different types of manual Work Orders (ad hoc, preventive maintenance, and emergency maintenance).
- SR520-4.107 The Work Order shall record the source of the Work Order, either as automatically triggered by MOMS monitoring, or the person reporting the failure (Vendor maintenance technician, WSDOT staff member, or both).
- SR520-4.108 The MOMS shall also provide for the capability to build ad hoc Work Orders for unusual occurrences of maintenance activities.
- SR520-4.109 A Work Order shall include, but not be limited to, the following information:
- a. Date/time of Work Order generation
 - b. Date/time/location of repair or maintenance call
 - c. Work Order number (sequential)
 - d. Work Order priority
 - e. Work Order status
 - f. Work Order assignment details
 - g. Failure or malfunction description
 - h. Repair/diagnosis details
 - i. Usage of spare parts
- SR520-4.110 The MOMS shall provide the capability to generate blank Work Orders for repairs or malfunctions not directly reported by the MOMS.
- SR520-4.111 Blank Work Orders shall still be generated for the sequential list maintained in MOMS.
- SR520-4.112 The MOMS shall provide a search feature which allows users to search for Work Orders either through the use of or in combination with text entry, pull down menus, and data range entry by:
- a. Date/time of Work Order generation
 - b. Date/time/location of repair or maintenance call
 - c. Work Order number (including **Wildcard** operators)
 - d. Work Order priority
 - e. Work Order status
 - f. Work Order assignment details
 - g. Repair/diagnosis details

- h. Usage of spare parts
- i. Failure or malfunction description

SR520-4.113 The MOMS shall provide a drill down feature; where it begins with a listing of all Work Orders and the ability to drill down to the detail level for individual Work Orders.

SR520-4.114 The MOMS shall track and provide reporting functionality for **Functional Availability**, **MTTRespond**, and **MTTRepair**.

3.3.4.3. Notification

SR520-4.115 The MOMS shall provide an automatic ticket generator for automated notification of maintenance issues.

SR520-4.116 The MOMS shall allow both automatic and manually activated notification of technicians once a Work Order has been generated.

SR520-4.117 The MOMS shall allow for users to set parameters for all error notifications, status changes, and escalation rules.

SR520-4.118 The MOMS shall automatically notify technicians of changes in the Transaction counts and performance of the OCR established by user-configurable thresholds.

SR520-4.119 The MOMS shall provide the capability to notify technicians, at a minimum, through the use of paging, **SMS**, and e-mail.

SR520-4.120 E-mail-based notifications shall include a unique and descriptive subject line related to the failure or malfunction (e.g. Lane Controller A failed in Zone #1, Lane #1).

SR520-4.121 The preventive maintenance schedule shall be integrated with the MOMS to generate automatic Work Orders at scheduled times.

3.3.4.4. Spare Parts

SR520-4.122 The MOMS shall provide an integrated spare unit and spare parts inventory control function.

SR520-4.123 The MOMS shall integrate inventory control with the Work Order generation function, which shall automatically update and maintain the System and spare parts inventory based on Work Orders and technicians recording of parts used during Work Order close-out.

SR520-4.124 The MOMS shall create automatic notifications when new parts are required due to changes in inventory, established by user-configurable thresholds.

3.3.4.5. Availability Tracking

SR520-4.125 On a monthly basis, the System shall be available 99.0% of the month.

SR520-4.126 **Availability** calculations shall consider the following subsystems:

- a. Image Capture
- b. Vehicle Detection and Classification
- c. Automatic Vehicle Identification
- d. Digital Video Auditing System
- e. Optical Character Recognition

SR520-4.127 The System shall be considered available when at least one (1) device per lane from each of the five (5) subsystems replies to a ping sent by the Host at a configurable frequency.

SR520-4.128 If one of the five (5) subsystems is unavailable, the entire System shall be considered unavailable.

SR520-4.129 Every unavailable incident (outage) during each month shall be tracked by the MOMS and reported.

SR520-4.130 During Shared Maintenance, the Availability calculations will also consider responsible party. These details will be mutually agreed to between WSDOT and the Vendor if Shared Maintenance is enacted.

SR520-4.131 The MOMS Availability calculations shall be performed automatically whenever the Availability report is run.

3.3.5. Mean Time To Respond and Repair

SR520-4.132 The MOMS shall be capable of tracking and calculating the Mean Time To Respond (MTTRespond) and Mean Time To Repair (MTTRepair) of the System-related Products.

SR520-4.133 The MTTRespond and MTTRepair calculations shall be performed automatically whenever the MTTRespond/Repair report is run.

SR520-4.134 The MOMS shall denote all deductions to MTTRespond and MTTRepair individually.

SR520-4.135 The MTTRespond and MTTRepair shall take into account the number of installed pieces of Products and the number of service calls closed on the same Product.

3.3.6. Reporting

- SR520-4.136 The Host shall provide the capability for users to generate and produce reports based on predefined and ad hoc report criteria.
- SR520-4.137 No black out period shall exist for running reports.
- SR520-4.138 The Host shall allow the user to edit and view the report selection parameters.
- SR520-4.139 The Host shall create scheduled and ad hoc reports automatically and e-mail and/or save them as defined by the user.
- SR520-4.140 The ability to support inquiries and the generation of reports shall be available twenty-four (24) hours per day, seven (7) days per week.
- SR520-4.141 Reporting shall include daily, weekly, monthly, yearly, day of week, day of year, week of month, and week of year recurrence criteria.
- SR520-4.142 Reporting shall be output, saved, or printed in the following formats including, but not limited to: on-screen, ODF, PDF, HTML, comma-separated values (text), and Microsoft Excel.
- SR520-4.143 All data entered into or generated by the System shall be retrievable through screens and reports.
- SR520-4.144 The Host shall include the capability for tabular and graphical display of data, as appropriate.
- SR520-4.145 The Host shall provide for system-wide auditing capabilities for all Transactions.
- SR520-4.146 The Host shall have the capabilities of retrieving data for:
- a. Any given date/time Transaction
 - b. Any given lane or Toll Zone
 - c. Any given classification
 - d. Transaction type
- SR520-4.147 The Host reports shall provide relevant overall information, such as column and row totals, percentage splits, and basic statistics, such as minimum, maximum, and average.
- SR520-4.148 The Host shall have the capability to report on power information such as power fluctuations, on/off state changes, and other anomalies.

3.3.6.1. Defined Reports

SR520-4.149 The Host shall generate a range of reports, for user-configurable periods of time, but at least monthly, of which the content and form shall be submitted to WSDOT for approval. The reports shall include, but not be limited to:

- a. Users and user groups
- b. Toll fare schedule
- c. Misclassifications
- d. Transactions detail to include, but not limited to:
 - i. Traffic volumes by classification
 - ii. Transaction type
 - iii. Average speed
 - iv. Traffic density
- e. Traffic volume

SR520-4.150 The MOMS shall generate various operational, management, and performance reports from the MOMS, of which the content and form shall be submitted to WSDOT for approval, including but not limited to:

- a. Summarized and detailed component failure history
- b. Maintenance paging and response history
- c. Work Order status and tracking
- d. Availability for devices, subsystems, and systems;
- e. Device status monitoring for devices, subsystems, and systems
- f. Preventive maintenance
- g. Emergency maintenance
- h. Response and repair times
- i. Product inventory and tracking
- j. Product use history
- k. Product repair history
- l. Product versions, Software versions, firmware versions, and serial numbers for all Product installed under the Contract

SR520-4.151 The Availability report shall take into account the number of installed Toll Zones and the length of outages affecting the particular Toll Zone function.

- SR520-4.152 The Availability report shall be provided for user-configurable periods of time, but no less than monthly.
- SR520-4.153 The file transmission report shall show the status of the Transponder status file sent to the FMAS server, the CSC, and to all of the tolling locations/lanes. Time of receipt, time of transmission, and the status of the transmission shall be displayed.
- SR520-4.154 The OCR performance report shall display OCR performance statistics, including quantity of images taken, OCR results, and confidence levels.
- SR520-4.155 Weekly and monthly reports shall be available that show the user access data and modifications made, and the ability shall be provided to obtain the details of the modifications.

3.3.6.2. Ad Hoc Reports

- SR520-4.156 The Host shall allow users to format and generate ad hoc reports from all of the databases that are provided with the System.
- SR520-4.157 The design of ad hoc reporting capability shall protect the System from being adversely affected by processing load caused by reporting functions.
- SR520-4.158 The design of ad hoc reporting capability shall protect the on-line database from corruption caused by reporting functions.
- SR520-4.159 Table views shall be provided to simplify ad hoc queries.
- SR520-4.160 Ad hoc reports shall include the capability for various selection and sort criteria.
- SR520-4.161 Ad hoc queries shall be able to be saved by query name for later recall.
- SR520-4.162 Reports generated from ad hoc queries shall be savable in a format that can be opened by Microsoft Excel or compatible program.

3.3.7. Technology Requirements

- SR520-4.163 The System shall be compatible with the current WSDOT-approved version of Crystal Reports.
- SR520-4.164 The System shall be supported by Commercial Off-the-Shelf (**COTS**), general-purpose Software that will provide standard system utilities, for example:
- a. Computer operating systems
 - b. System database
 - c. System reporting

- d. System backup, archive, and restore functions
- SR520-4.165 The Host shall utilize an automatic fail-over system that ensures minimal downtime and does not require user intervention to facilitate the fail-over.
- SR520-4.166 The Host shall store data utilizing a **RAID** 1+0 configuration and be hot-swappable.
- SR520-4.167 The System shall provide **SQL** access to Toll Zone Transaction data and audit data for Authorized Users.
- SR520-4.168 The design of the SQL access capability shall protect the Host from being adversely affected by processing load caused by this SQL access.
- SR520-4.169 The design of the SQL access capability shall protect the online database from corruption caused by this SQL access.
- SR520-4.170 The FMAS shall provide the following features:
 - a. **Graphical User Interface**
 - b. Server redundancy to prevent down-time and protect data
 - c. Automatic archiving
- SR520-4.171 A **Relational Database Management System (RDBMS)** shall be utilized to store data collected throughout the System. Data tables, such as AVI Transactions, image-based Transactions, System events, maintenance events, etc., shall be maintained within the database.
- SR520-4.172 The RDBMS shall allow flexibility in reporting and allow ad hoc system reporting through use of a report generator. Data in the database shall be accessible to other applications through the use of **ODBC** utilities.
- SR520-4.173 The RDBMS shall be provided to meet the functionality described throughout this document and be compatible with the Network (**LAN**), server, and workstation environments described in this document.
- SR520-4.174 The RDBMS shall provide the common functionality, elements, and capabilities encountered in commercially available RDBMSs.
- SR520-4.175 The RDBMS shall have internal features to help prevent unauthorized access to stored information.
- SR520-4.176 Any Vendor-provided Product to be used in connection with the System network shall utilize connectors and cable, rated and capable of connecting at speeds of 1000 Mbps.

3.3.7.1. Data Protection

SR520-4.177 The Vendor shall protect all data in accordance with ISB security policies and standards available at <http://isb.wa.gov/policies.aspx>.

SR520-4.178 The Vendor shall provide data and anti-virus protection throughout the System, including, but not limited to, the following environments:

- a. Lane
- b. Host
- c. Workstations
- d. External system interfaces
- e. Remote access locations (Vendor controlled)
- f. Internet

SR520-4.179 Data and anti-virus protection shall include, but not be limited to:

- a. Password data security at workstation login;
- b. Data backup subsystems
- c. Boot record and memory virus scanning
- d. Disk and tape virus scanning
- e. Communication link and data packet virus scanning
- f. Import and export file virus scanning prior to standard file opening and/or transfer

SR520-4.180 The Vendor shall, at a minimum, provide the following:

- a. The latest version of anti-virus at the time of **System Acceptance**
- b. Update service within fifteen (15) Calendar Days of update issuance for the virus dictionary and/or virus scanning Software throughout the warranty, maintenance period and any optional maintenance periods
- c. Anti-virus operational procedures

3.3.8. Back Up and Recovery

SR520-4.181 The System shall back up data to Linear Tape-Open generation three (**LTO-3**) compatible tapes accessible by Computer Associates' ARCserve version 12.

SR520-4.182 The databases shall include Software that allows the user to configure the scheduling of the backups.

SR520-4.183 The System backup processes shall be designed to minimize the potential loss of data.

- SR520-4.184 Backup processes shall not interfere with normal operation of the System or running of reports.
- SR520-4.185 Data shall be staged and archived at a user-configurable interval to ensure maximum System performance.
- SR520-4.186 The System shall allow the archived data to be reloaded on the System for possible future examination, processing, or printing.
- SR520-4.187 Backups shall be performed no less than once per day.
- SR520-4.188 The System shall store detailed MOMS data for the life of the Contract.
- SR520-4.189 The System shall store offline Transaction data and images for a period of one (1) year.
- SR520-4.190 The System shall store summarized daily traffic data for a period of five (5) years.

3.3.9. Security

- SR520-4.191 The System shall restrict access to all Lane Controller and Host applications to Authorized Users that shall be configurable by **System Administrators**.
- SR520-4.192 The Vendor shall meet or exceed all ISB security policies and standards available at <http://isb.wa.gov/policies.aspx>.

3.4. Digital Video Audit System (DVAS)

3.4.1. General

- SR520-4.193 The Vendor shall provide one or more cameras mounted upstream or downstream of the tolling point to provide a continuous video feed of the traffic passing through the Toll Zone.
- SR520-4.194 The Transaction details taking place in the Toll Zone shall be overlaid on the video image so as to enable the viewer to associate vehicles with Transaction data and judge the overall apparent “health” of the System.
- SR520-4.195 The data overlaid on the screen shall include all Transaction data captured for each vehicle passing through the Toll Zone.
- SR520-4.196 The DVAS shall only record and store activities when motion activated.
- SR520-4.197 The camera shall be positioned such that the front or rear of a 50-foot vehicle traveling at the posted speed will still be in the camera’s view for at least an additional second when the overlay appears on the screen.

- SR520-4.198 The overlay shall be formatted on the screen in such a manner that the viewer can easily correlate the vehicle on the screen with the Toll Zone lane the System believes the vehicle traveled on.
- SR520-4.199 The viewable video and text shall be human readable, and not contain any flickers or fluctuations in the display image.
- SR520-4.200 This camera shall serve to provide images for use in visually determining vehicle class, including visual shape or axle count verification.
- SR520-4.201 A sufficient DVAS video feed shall be captured to assure a usable image of the vehicle is obtained for vehicles traveling up to and including 100 MPH.
- SR520-4.202 The camera location shall be chosen so as to minimize the probability of obstructions due to other vehicles.
- SR520-4.203 The DVAS shall stream the monitoring video signal in **MPEG 2** or **MPEG 4** format.
- SR520-4.204 The DVAS shall capture, stream, and store video at fifteen (15) or greater frames per second.
- SR520-4.205 The DVAS shall capture and store video at a resolution that captures a human readable license plate within the field of view.
- SR520-4.206 The Vendor shall supply the Products to record and view the real-time and archived data.
- SR520-4.207 The DVAS shall enable the viewer to display a single Toll Zone's monitoring video or to view at least two (2) Toll Zones simultaneously.
- SR520-4.208 Video shall be indexed and searchable for easy location of a specific time, date, and location.
- SR520-4.209 The DVAS shall have an interface which allows for the user to view live data or search and view archived data.
- SR520-4.210 The DVAS shall store data for ninety (90) Calendar Days on the Host or at an off-site storage location.

3.5. Communication

3.5.1. General

- SR520-4.211 The System shall operate within the WSDOT-provided communications network.

- SR520-4.212 All System Hardware shall be connected to the WSDOT communications network and be **IP** addressable.
- SR520-4.213 The System shall redundantly store Transaction data in the Lane Controller and the Host.
- SR520-4.214 The System architecture shall provide automated fail over capability for both the Lane Controller and the Host.
- SR520-4.215 The System shall ensure that all records are transferred from the Lane Controller to the Host by analyzing the sequence numbers for all message types checking for gaps, which will prompt a request from the Host to the Lane Controller for the missing information.
- SR520-4.216 The Vendor shall provide and install a new switch to connect from the WSDOT **SONET** ring to a Cisco **ASA** 5520 firewall in order to protect the SR 520 network from the Internet. The media used for the Internet connection shall be a T-1 circuit. See Figure 3 in Appendix 2 for more detail.

3.6. User Interfaces

3.6.1. General

- SR520-4.217 The Graphical User Interfaces (GUI) shall be a hierarchical, menu-driven system.
- SR520-4.218 Access to functions and features shall be limited to Authorized Users based on user accounts and roles developed by WSDOT and the Vendor during the System design process.
- SR520-4.219 All interfaces shall display time in local Pacific Standard Time, standard AM/PM format, and be automatically adjusted for daylight savings time.
- SR520-4.220 Any user interface in the Software shall not require elevated system privileges on the user's workstation.
- SR520-4.221 All user interfaces shall be Web-based, browser agnostic, graphical in nature, and compatible with the current WSDOT-deployed Windows operating system (currently, Windows XP).

3.6.2. FMAS

- SR520-4.222 The FMAS shall provide an interface facilitating the update and download of modified, updated, or new vehicle classification and toll rate tables.
- SR520-4.223 The FMAS shall provide a Web-based interface for authorized WSDOT users over the WSDOT **WAN**.

- SR520-4.224 The FMAS shall provide a user display and interface for the monitoring of lane activities and Products installed at each Toll Zone.
- SR520-4.225 The FMAS shall present data and information in a graphical manner.
- SR520-4.226 The FMAS shall display the status of all lane Products and related communications.
- SR520-4.227 The FMAS shall display the last image captured for each camera.
- SR520-4.228 The FMAS shall display the status of all computer Hardware and related communications using a WSDOT-approved color scheme.
- SR520-4.229 The FMAS shall display the AVI utilization rate for all reader locations as they occur and over user defined time intervals.
- SR520-4.230 The FMAS shall provide a user interface to the Lane Controller.
- SR520-4.231 The FMAS GUI shall allow Authorized Users to view, modify, add, and remove a wide range of database settings, configurations, and parameters.
- SR520-4.232 At a minimum the GUI shall provide the following:
- Users and user groups—create and modify users and user information and assign users to a user group; defines a user group and its access level to program functions, nodes, and reports
 - System functions—defines the make-up of the System nodes (e.g., Lane Controllers) and computers (workstations)
 - Toll classification table—defines the different vehicle declaration states and classifications
 - Toll rate table—defines the times, days, declaration states, classification types, and toll rates
 - Global configuration—defines global parameters of the System

3.6.2.1. System Administration

- SR520-4.233 The FMAS shall control and manage the System administration for all aspects of the System.
- SR520-4.234 The FMAS shall facilitate system administration for the System at its current size and it shall be **Scalable** to accommodate a future SR 520 bridge.
- SR520-4.235 The FMAS shall support vehicle classification and toll rate table changes via an effective date that specifies the date and time after which the old tables are no longer used and the new tables go into effect.

SR520-4.236 Application restarts shall not cause a loss of Transaction information or loss of log file data.

3.6.2.2. System Monitoring

SR520-4.237 The status display shall consist of graphics, symbols, text, and/or numerals (which will be finalized during the design phase).

SR520-4.238 The user shall not have to refresh the screen or display to show the latest status, image captured, and/or Transaction logged.

SR520-4.239 The user shall have access to view near real-time Transaction data from any workstation on the network with the proper authorization.

SR520-4.240 The user shall have access to view near real-time Image Capture.

SR520-4.241 Each device and subsystem status shall be indicated in color, e.g., green—“healthy”, yellow—“degraded” or “ailing”, red—“failed”.

SR520-4.242 The display shall indicate communication link status with each device, e.g., graying of the device upon communication loss.

3.7. System Interfaces

An Interface Control Document (ICD) currently does not exist to determine how data should be exchanged between the CSC and System. The Vendor shall assist WSDOT and the CSC Vendor in developing the ICD. The following fundamental data shall be exchanged between the System and CSC and documented in the ICD:

- a. Transponder status information (from CSC to System)
- b. Transponder and license plate association information (from CSC to System).
- c. Transaction information (from System to CSC)
- d. Images and image/OCR information (from System to CSC)
- e. Data transfer complete information (from sender to receiver)
- f. Data received and processed information (from receiver to sender)

The Vendor shall use, as a template for the new ICD, the Tacoma Narrows / SR167 Hot Lane Integration ICD which maintains these basic criteria:

- a. Data Format: **XML** formatted files
- b. Data File Transmission Method:
 - i. Via **FTP** Server
 - ii. Over the Internet
 - iii. Files are compressed (zipped) and encrypted

- c. Data File Transmission Frequency:
 - i. Tag Status File: sent by CSC twice per day (all assigned tags)
 - ii. Transaction File: sent by the System once per day
 - iii. Transfer Complete File: sent by sender for each file transferred
 - iv. Acknowledgement File: sent by CSC for each Transaction file (transaction based)

The following general assumptions for data exchange will be maintained during the new ICD developments:

- a. One ICD is developed for all WSDOT TCS's (i.e., Tacoma Narrows Bridge, SR 167, SR 520, and future facilities)
 - i. The actual ICD will be co-developed by all vendors (i.e. TransCore, Electronic Technology Consultants Corporation, new CSC Vendor, and Vendor); CSC Vendor will act as the document owner
 - ii. The CSC Vendor will submit the final ICD to WSDOT from review and approval
 - iii. Modifications to the SR 167 ICD are minimized
- b. Data exchange is reliable, and cost effective
 - i. Single-points of failure are minimized
 - ii. Costs are minimized (initial and on-going)
- c. Data is exchanged efficiently
 - i. Necessary data is exchanged (current and future needs)
 - 1. data content
 - 2. data quantity & volume
 - ii. Data exchange functions do not adversely affect other functionality
 - 1. data packaging
 - 2. data transmission
- d. Data is exchanged securely
 - i. data is encrypted during transmission
 - ii. secure path is utilized (e.g., VPN over the internet)
 - iii. transmitting and receiving systems have access protection
- e. Data integrity is ensured (e.g., checksums are utilized)
- f. "Safety-nets" are utilized
 - i. Data is not processed until completely transmitted
 - ii. Data is re-transmitted if not acknowledged

- g. All data, with the exception of images, will be “pushed”. The CSC will “pull” images as needed from the System

3.7.1. CSC

- SR520-4.243 The FMAS shall immediately receive the Transponder status file and all related update files when it is available from the WSDOT CSC. This shall occur at least once a day.
- SR520-4.244 The FMAS shall immediately receive the incremental Transponder status file and all related update files when it is available from the WSDOT CSC. This shall occur at least once an hour.
- SR520-4.245 The FMAS shall transmit the Transponder status file and all related update files to each Lane Controller immediately after receipt from the CSC. Where a Lane Controller is offline, the FMAS shall retry, a user-configurable number of times, to transmit the data to the Lane Controller.
- SR520-4.246 The FMAS shall transmit the Transaction file to the CSC FTP every ten (10) minutes.
- SR520-4.247 The FMAS shall store video images in an FTP server that shall transmit upon request by the WSDOT CSC.
- SR520-4.248 The FMAS shall interface with the CSC according to the WSDOT CSC ICD, which will be developed collectively with WSDOT, the CSC Vendor, and the Vendor.

3.7.2. SIMMS

- SR520-4.249 The Vendor shall use the SIMMS ICD as a baseline.
- SR520-4.250 The MOMS shall interface with the WSDOT SIMMS to transmit and receive failure alerts and notifications.
- SR520-4.251 This interface shall be activated no later than ninety (90) Calendar Days before the transfer of any maintenance responsibilities from the Vendor to WSDOT.

3.7.3. Traffic Management Center (TMC)

- SR520-4.252 WSDOT shall supply and deliver to the Vendor for configuration the following equipment:
 - a. Cisco Catalyst 2960 Series Switch
 - b. Cisco ASA 5520 Firewall
- SR520-4.253 The Vendor shall supply and configure the following Products:
 - a. Rack-mounted Keyboard, Video, and Mouse (local user)

b. FMAS

SR520-4.254 The Vendor shall deliver the following pre-configured Product?? the FMAS seems to be more than just equipment to WSDOT for installation at the TMC:

- a. Cisco Catalyst 2960 Series Switch
- b. Cisco ASA 5520 Firewall
- c. Rack-mounted Keyboard, Video, and Mouse (local user)
- d. FMAS

3.7.4. Data Transfer

SR520-4.255 The electronic transfer of data between the Host and the CSC shall include a mechanism for ensuring that the data transfer has successfully transmitted the correct data and provide a daily reconciliation report on the information transferred.

SR520-4.256 The Host shall provide the ability to electronically copy Transactions to a portable electronic media for delivery to the CSC in the event of a communication loss.

SR520-4.257 The Lane Controller shall provide the ability to electronically transfer Transaction and maintenance data to a portable electronic media for delivery to the FMAS.

SR520-4.258 The electronic transfer of data between the MOMS and SIMMS shall include a mechanism for ensuring that the data transfer has successfully transmitted the correct data and provide a daily reconciliation report on the information transferred.

SR520-4.259 The electronic transfer of data between the Host and TMC shall include a mechanism for ensuring that the data transfer has successfully transmitted the correct data and provide a daily reconciliation report on the information transferred

SR520-4.260 The configuration files, classification tables, etc., shall be transmitted to the applicable system immediately upon update.

4. SECURITY

4.1. System Security

SR520-4.261 The System shall comply with applicable ISB security requirements as provided on the **DIS** website, <http://isb.wa.gov/policies.aspx>.

SR520-4.262 The System shall use **LDAP** authentication.

SR520-4.263 The LANs at each Toll Zone for the System shall be connected through WSDOT-provided WAN; through a triple DES encoded tunneling security protocol.

SR520-4.264 The Vendor shall provide clientless Virtual Private Network (VPN) access to the System to allow for remote access by Authorized Users and maintenance by the Vendor's staff.

SR520-4.265 The System shall permit only System Administrators access to the RDBMS server for system maintenance, Software upgrades, backup, archiving, restoration and performance monitoring and tuning. All such access shall be logged and all actions conducted by the System Administrator shall be recorded.

SR520-4.266 All System Administrator-related activities shall be performed through database management system utilities and command files.

SR520-4.267 If dynamic SQL-based update to the database is required, such updates shall only be performed with documented SQL command files that are fully logged and filed.

SR520-4.268 There shall be no direct user access to the Host RDBMS. All access to the Host RDBMS shall be through Host middleware.

SR520-4.269 User authentication and access to the Host RDBMS shall be managed by the middleware application services using generic or function-related database connections.

SR520-4.270 All Host RDBMS scheduled jobs shall be executed under a non-interactive account.

SR520-4.271 The Host RDBMS shall not permit any modifications or deletions of the original Transaction records stored in the Host database exclusive of archive functionality.

SR520-4.272 All Host RDBMS records shall support version control and record traceability at the field level.

SR520-4.273 Each user shall be uniquely identifiable (e.g., user name, or user ID). The System shall authenticate each user's identity with a password.

- SR520-4.274 Passwords shall meet ISB security requirements.
- SR520-4.275 The System shall assign access rights to individual users. The System shall define access for users and/or defined sets of users and objects (e.g., files, database elements, and applications).
- SR520-4.276 The System shall provide the capability to control access between named users and/or defined sets of users and named objects (e.g., files, database elements, and applications).
- SR520-4.277 The System shall restrict access to objects based on the user's and/or defined sets of users' identity and on access rights (e.g., read, write, execute).
- SR520-4.278 The System shall provide the capability to restrict access to Transponder ID numbers and license plate numbers to WSDOT-authorized individuals, which shall be a parameter separate from any other access right parameter.
- SR520-4.279 The System shall discontinue the user session if user input devices have been idle for longer than a time period of "n" minutes, where "n" is configurable by the System Administrator.
- SR520-4.280 The System shall provide the capability to audit the following types of events:
- a. Use of identification and authentication mechanisms
 - b. Actions taken by trusted users
 - c. Change in access control permissions
 - d. System startup
 - e. System shutdown
 - f. The System shall associate the user's identity with all auditable actions taken by that user.
 - g. The System shall be able to enable and disable auditable events.
 - h. The System shall allow a System Administrator to define System security-related events.
 - i. The System shall provide access to application-level audit data (e.g., Windows event log).
 - j. The System shall allow for reporting of audit data that has been collected.
- SR520-4.281 The database application must include current required System security measures for protecting customer and WSDOT

4.2. Physical Security

SR520-4.282 All Roadside System shall be access controlled.

SR520-4.283 Access to all roadside enclosures shall be recorded automatically and be reported to the MOMS.

SR520-4.284 The data reported shall include, but not be limited to, shelter and enclosure status, user (if card access), date, time of entry and exit, and any applicable alarm conditions.

5. SAFETY

- SR520-4.285 Vendor shall take all reasonable precautions and be solely responsible for the safety of, and shall provide protection to prevent damage, injury, or loss to, all persons and property that would reasonably be expected to be affected by the Work, including but not limited to, individuals performing Work, employees of WSDOT and FHWA and their consultants and invitees, and members of the public.
- SR520-4.286 The Vendor shall adhere to all applicable safety standards and guidelines for working on or around construction zones, energized equipment, active roadways, and a maintenance environment, including but not limited to the following:
- a. WSDOT safety procedures and guidelines
 - b. State of Washington Department of Labor and Industries
 - c. **OSHA**
 - d. NEMA
 - e. **NEC**
 - f. Any other local, state, or **Federal** ordinance, procedure, or guideline that provides for a safe operation and working environment.
- SR520-4.287 The Vendor shall arrive onsite within forty-five (45) minutes of any incident that threatens or may threaten the safety of the highway facility, the users thereof, and any other person or property whatsoever.

* * * End of Appendix * * *